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Brief Communication

# Prevalence of pre-stroke sleep apnea risk and short or long sleep duration in a bi-ethnic stroke population

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ABSTRACT

*Background:* The ethnic disparity in ischemic stroke between Mexican Americans (MAs) and non-Hispanic whites (NHWs) may be partly attributable to disparities in sleep and its disorders. We therefore assessed whether pre-stroke sleep apnea symptoms (SA risk) and pre-stroke sleep duration differed between MAs and NHWs.
*Methods:* MA and NHW ischemic stroke survivors in the Brain Attack Surveillance in Corpus Christi (BASIC) project reported sleep duration and SA symptoms on the validated Berlin questionnaire, both with respect to their pre-stroke baseline. Log binomial and linear regression models were used to test the unadjusted and adjusted (demographics and vascular risk factors) associations of high-risk Berlin scores and sleep duration with ethnicity.
*Results:* Among 862 subjects, 549 (63.7%) were MA and 514 (59.6%) had a high risk of pre-stroke SA. The MA and NHW subjects showed no ethnic difference, after adjustment for potential confounders, in pre-stroke SA risk (risk ratio (95% confidence interval (CI)): 1.06 (0.93, 1.20)) or in pre-stroke sleep duration (on average MAs slept 2.0 fewer minutes than NHWs, 95% CI: −18.8, 14.9 min).
*Conclusions:* Pre-stroke SA symptoms are highly prevalent, but ethnic differences in SA risk and sleep duration appear unlikely to explain ethnic stroke disparities.


## 1. Introduction

Mexican Americans (MAs), the largest subgroup of Hispanics, have a higher risk of first and recurrent stroke than do non-Hispanic whites (NHWs), with nearly double the risk at younger ages [1]. Reasons for this ethnic disparity are uncertain, but could include an increased prevalence of sleep disorders, such as sleep apnea (SA), an independent stroke risk factor [2]. Similarly, self-reports of short (<7 h) or long (>9 h) sleep duration are associated with an increased risk of stroke [3]. Studies suggest that Hispanics may have a higher prevalence of SA and higher odds of longer sleep compared to NHW [4,5].

Information about pre-stroke SA and sleep duration would allow hypotheses to be generated about the contributions of short or long sleep or disordered sleep to elevated stroke risk in MAs compared with NHWs. Our aim was to compare pre-stroke SA and sleep duration in MAs and NHWs included in a population-based stroke study. We hypothesized that MAs would have a higher prevalence of pre-stroke SA and shorter or longer sleep duration than NHWs.

## 2. Methods

Subjects were recruited between 7/8/2010 and 1/20/2014 from the Brain Attack Surveillance in Corpus Christi (BASIC) Project, an ongoing, population-based stroke surveillance study conducted in the bi-ethnic community of Nueces County, TX. Our hospital surveillance captures nearly all cases of ischemic stroke and detailed methods have been published previously [1,6,7]. Briefly, stroke cases from all seven acute care hospitals in Corpus Christi are identified through active surveillance of the emergency department and hospital logs and passive surveillance of ICD-9 codes. Complete case capture is facilitated through the geographic isolation of the community with only sparsely populated surrounding areas. The lack of an academic medical center in the area limits referral bias. Study neurologists validate each case based on review of source documentation. The current analysis is restricted to ischemic stroke patients who agreed to undertake a study interview. The

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Institutional Review Boards of the University of Michigan and the local hospitals approved this project. Informed consent was obtained from each subject or surrogate.

Demographics and medical history were obtained from the medical record and a baseline interview, with the subject or a proxy if the subject was unable to participate. Ethnicity was defined by chart designation, which we have previously shown has a 96.3% agreement with self-report in this community [8]. During the baseline interview, the Berlin questionnaire, a validated SA screening tool, and a sleep duration question ("How many hours of sleep do you usually get a night (or when you usually sleep)?") were asked in reference to the pre-stroke state [9]. The Berlin questionnaire has an 89% positive predictive value for detecting SA (apnea/hypopnea index (AHI) ≥ 5) and 71% negative predictive value (detecting no SA with AHI <5) in a primary care setting [9]. The Berlin questionnaire was used to screen for SA in the Sleep in America 2005 poll and other studies [10–13]. The questionnaire consists of three categories that query snoring/apneas (category 1), sleepiness (category 2), and hypertension and body mass index (BMI) > 30 (category 3). Each category is scored as low (0) or high risk (1), and an individual is considered high risk if two or more category scores are high risk. The total reported sleep duration was further categorized as short (≤6 h), long (≥9 h), or normal (7–8 h), based on typical classifications [14]. With an estimated 50% prevalence for overall high-risk pre-stroke SA, we had 82% power to detect a risk ratio of 1.2 for pre-stroke SA in MAs compared with NHWs given our sample size.

Descriptive statistics summarized baseline characteristics, Berlin scores, and sleep duration. Unadjusted ethnic comparisons for categorical and continuous variables, including sleep duration (hours), were made by chi-square and Kruskal–Wallis tests. Log binomial regression with robust standard errors was used to test the unadjusted and adjusted associations between high-risk Berlin score overall and Berlin category scores and ethnicity. Two separate models (model 1 and model 2) were used to adjust for prespecified potential confounders including age (continuous), sex, current smoking status, current alcohol intake (categorical: < 1, 1–14, and >14 drinks per week), diabetes, high cholesterol, atrial fibrillation, hypertension, and BMI (quintiles). Model 1 tested the adjusted association between high-risk Berlin score overall or category 3 and ethnicity. Hypertension and BMI were not included in model 1 as these variables are part of the definitions of category 3 and the overall score. Hypertension and BMI were additionally included in model 2, which tested the adjusted association between category 1 or 2 and ethnicity. Linear regression with robust standard errors tested the unadjusted and adjusted (same prespecified confounders) difference in sleep duration (≤6 h, 7 or 8 h, and ≥9 h) by ethnicity. SAS version 9.3 (SAS Institute, Cary, NC, USA) was used for analyses.

## 3. Results

During the study period, there were 1419 validated ischemic strokes among MAs and NHWs. There were 134 patients excluded because >6 months elapsed between the stroke and the interview, the interview was pending or they completed the interview, but not the sleep questions. Of 1285 eligible patients with validated ischemic strokes, 862 (67.1%) completed the interview that included sleep questions; 549 (63.7%) of these subjects were MA. The baseline characteristics are shown in Table 1. Proxies completed the surveys for 272 (31.5%) of subjects, with no ethnic difference ($p = 0.30$). MAs had a greater prevalence of diabetes, hypertension, and a higher BMI, but a lower prevalence of atrial fibrillation, smoking, and lower use of alcohol compared with NHWs. MAs were also less likely to complete high school or post-high school education than NHWs.

Overall, 514 (59.6%) subjects had a high risk of pre-stroke SA, which was more common in MAs (61.9%) than NHWs (55.6%), but

**Table 1**
Baseline characteristics and pre-stroke sleep duration among stroke subjects in BASIC.

| | All $n = 862$ $n$ (%) | Mexican American $n = 549$ $n$ (%) | Non-Hispanic whites $n = 313$ $n$ (%) | $p$-value |
|---|---|---|---|---|
| Female | 419 (48.6) | 272 (49.5) | 147 (47.0) | 0.47 |
| Age, median (IQR) | 69 (59, 80) | 67 (58, 79) | 71 (61, 82) | 0.003 |
| Health insurance | | | | |
| Nueces County, self-pay, or not insured | 125 (14.5) | 83 (15.1) | 42 (13.4) | <0.001 |
| Medicare/Medicaid, VA/Tricare/Champs | 211 (24.5) | 158 (28.8) | 53 (16.9) | |
| Private, or Private plus Medicare | 526 (61.0) | 308 (56.1) | 218 (69.6) | |
| Education | | | | |
| <High school | 340 (39.5) | 299 (54.7) | 41 (13.1) | <0.001 |
| High school | 231 (26.9) | 134 (24.5) | 97 (31.0) | |
| >High School | 289 (33.6) | 114 (20.8) | 175 (55.9) | |
| Current alcohol use | | | | |
| None | 212 (24.6) | 169 (30.8) | 43 (13.7) | <0.01 |
| <1 | 380 (44.1) | 242 (44.1) | 138 (44.1) | |
| 1–14 | 220 (25.5) | 108 (19.7) | 112 (35.8) | |
| >14 | 50 (5.8) | 30 (5.5) | 20 (6.4) | |
| Current smoker | 182 (21.1) | 98 (17.9) | 84 (26.8) | 0.002 |
| Proxy response | 272 (31.5) | 180 (32.8) | 92 (29.4) | 0.3 |
| BMI: $n$, median (IQR) | 859,27.44 (24.37, 32.42) | 547,28.53 (24.96, 33.28) | 312,26.32 (23.70, 30.27) | <0.001 |
| NIH stroke scale score, median (IQR) | 4 (2, 9) | 4 (2, 9) | 4 (2, 10) | 0.72 |
| Diabetes | 403 (46.8) | 313 (57.0) | 90 (28.8) | <0.001 |
| Hypertension | 699 (81.1) | 467 (85.1) | 232 (74.1) | <0.01 |
| Atrial fibrillation | 140 (16.2) | 70 (12.8) | 70 (22.4) | <0.01 |
| Congestive heart failure | 94 (10.9) | 60 (10.9) | 34 (10.9) | 0.98 |
| Coronary artery disease | 270 (31.3) | 169 (30.8) | 101 (32.3) | 0.65 |
| Stroke/TIA history | 257 (29.8) | 173 (31.5) | 84 (26.8) | 0.15 |
| Sleep duration | | | | |
| Total (hours), median (IQR) | 8 (6, 8) | 8 (6, 8) | 8 (6, 8) | 0.52 |
| Short, ≤ 6 h | 268 (31.4) | 177 (32.4) | 91 (29.6) | 0.67 |
| Normal, 7–8 h | 424 (49.7) | 269 (49.3) | 155 (50.5) | |
| Long, ≥ 9 h | 161 (18.9) | 100 (18.3) | 61 (19.9) | |

Abbreviations: IQR = interquartile range, VA = veterans administration, HMO = health maintenance organization, PPO = preferred provider organization.

**Table 2**
Ethnic differences in pre-stroke Berlin score and sleep duration.

| | All $n = 862$ | Mexican Americans $n = 549$ | Non-Hispanic whites $n = 313$ | Unadjusted RR or mean difference (95% CI) | Model 1 RR or mean difference (95% CI) | Model 2 RR or mean difference (95% CI) |
|---|---|---|---|---|---|---|
| Sleep apnea risk | | | | | | |
| High risk overall | 514 (59.6) | 340 (61.9) | 174 (55.6) | 1.11 (0.99, 1.26) | 1.06 (0.93, 1.20) | - |
| High-risk category 1 | 470 (54.5) | 311 (56.6) | 159 (50.8) | 1.12 (0.98, 1.27) | 1.09 (0.95, 1.25) | 1.05 (0.91, 1.20) |
| High-risk category 2 | 276 (32.0) | 176 (32.1) | 100 (31.9) | 1.01 (0.82, 1.24) | 0.87 (0.7, 1.07) | 0.86 (0.69, 1.07) |
| High-risk category 3[a] | 743 (86.2) | 495 (90.2) | 248 (79.2) | 1.13 (1.06, 1.21) | 1.11 (1.04, 1.18) | - |
| Sleep duration (min) | - | - | - | −5.4 (−22.1, 11.3) | −0.9 (−17.7, 15.8) | −2.0 (−18.9, 14.9) |

[a] $p < 0.001$.
Model 1 adjustment: age (continuous), sex, current smoking status, current alcohol intake (categorical: < 1, 1–14, > 14 drinks weekly), diabetes, hyperlipidemia, atrial fibrillation.
Model 2 additionally adjusted: BMI (quintiles) and hypertension. Overall Berlin score and category 3 scores were not adjusted for BMI and hypertension because they are part of the score itself.

not significantly ($p = 0.07$). Among the three Berlin categories, only high-risk category 3 was more prevalent among MAs, given their higher average BMI and prevalence of hypertension (Table 2). After adjustment, no ethnic differences in SA risk or in the symptom-based categories, category 1 and 2, were found. Approximately half of all subjects reported normal sleep duration (7 or 8 h), with no difference in sleep duration category distribution by ethnicity (Table 1). No difference in sleep duration was found by ethnicity before or after adjustment (Table 2). Additional post hoc adjustment for education level did not significantly change the relationship between SA risk or sleep duration and ethnicity.

## 4. Discussion

In this population-based stroke study, we found that a high risk of pre-stroke SA is common in stroke patients, but the prevalence of pre-stroke SA and short or long sleep duration was not higher in MAs than NHWs. Given our sample size, we had 82% power to detect a risk ratio of 1.2 for pre-stroke SA in MAs compared to NHWs, a small but clinically meaningful difference. These results suggest that differences between MA and NHW stroke patients in sleep duration and SA risk are unlikely explanations for important disparities observed in their cerebrovascular health. Such disparities could still be explained, in theory, by more severe SA in MAs or a stronger association between SA and stroke among MAs [2], and an alternative study design that included control subjects might have been more informative. However, the current negative results help to address a compelling question of vital importance that has never been investigated previously in a community sample of similar size.

One prior bi-ethnic study ($n = 176$) did assess pre-stroke SA risk, by the Berlin questionnaire, among 77 Hispanic (mostly Cuban descent) and 21 NHW subjects, and found a similar proportion of Hispanics (60%) at a high risk of SA, but a lower proportion of high-risk NHWs (33%) [15]. With adjustment, Hispanics had higher odds of SA. Differences in our results may relate to our larger sample, baseline differences in characteristics of NHWs, or our population-based design.

The main limitation of this study was the absence of objective measures for SA and sleep duration prior to stroke. Although the Berlin questionnaire may not be a good predictor of SA post stroke, it has been validated in general populations, and our use was in reference to the pre-stroke state [16]. Therefore, we would anticipate that it would perform as well as in the general population, though using it in reference to the pre-stroke state may introduce recall bias. Because some stroke patients were unable to complete the questionnaires due to aphasia or other stroke-related issues, some questionnaires were completed by proxies. However, bed partner responses to the Berlin questionnaire may predict SA based on polysomnographic criteria better than the patient, there is fair patient-proxy agreement for high-risk pre-stroke SA based on the Berlin questionnaire, and no ethnic difference in the use of proxies was identified ($p = 0.30$) [17,18]. Self-report of sleep duration is variably correlated with more objective measures of total sleep time, and may better reflect other constructs such as sleep quality or time in bed.

This population-based study provides evidence for a high prevalence of preexisting SA in stroke patients. However, no ethnic differences were identified in the prevalence of pre-stroke SA or sleep duration.

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## Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2014.09.007.

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